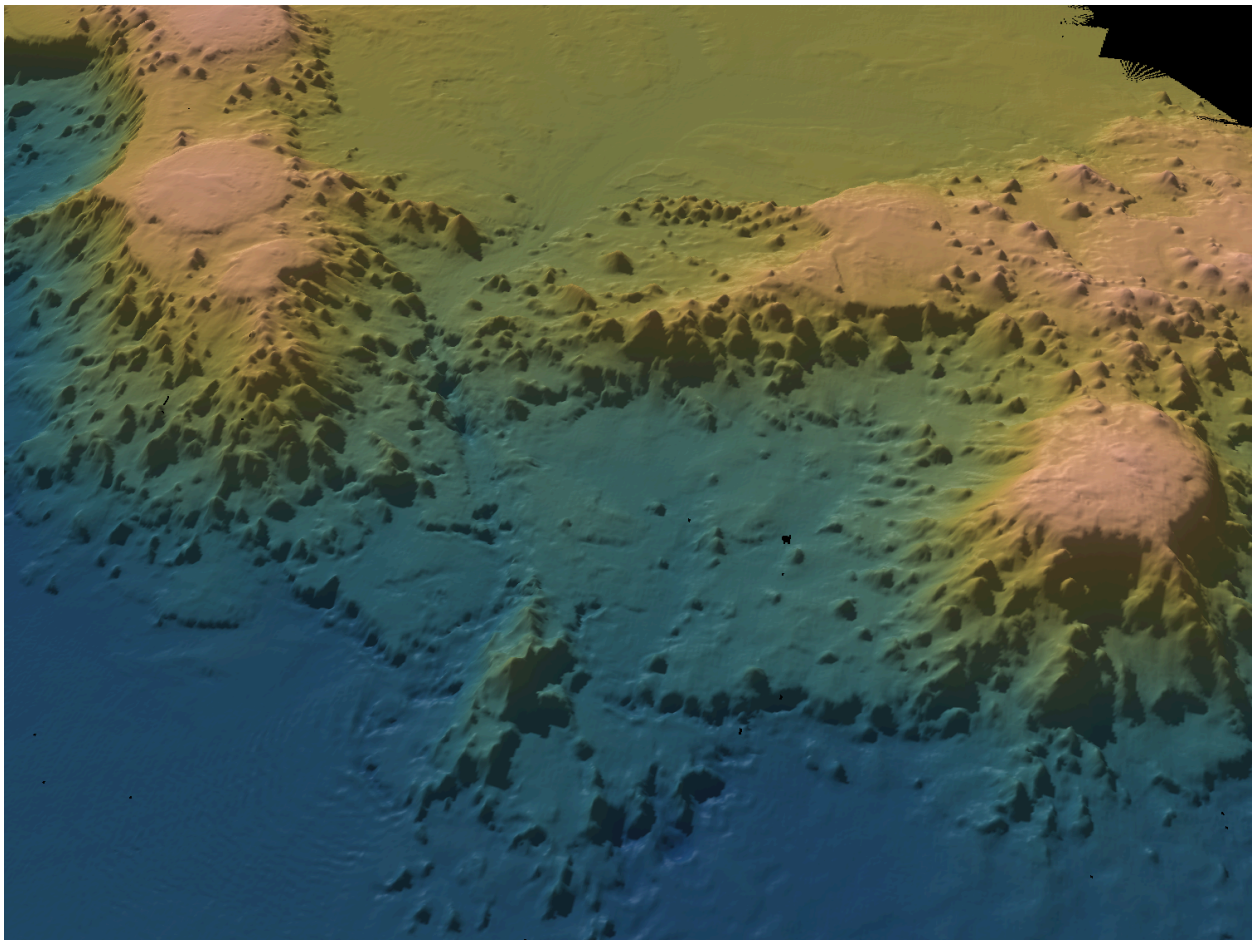
doi: 10.25923/7vs2-zr57

Expedition Report: EX2406, Beyond the Blue: Johnston Atoll Mapping



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September 10th, 2025

Abstract

From September 14-October 10, 2024 (Hilo, Hawai'i, to Honolulu, Hawai'i), NOAA Ocean Exploration conducted the Beyond the Blue: Johnston Atoll Mapping expedition (EX2406), a mapping expedition to the Johnston Atoll. EX2406 mapped 47,979 sq. km of seafloor (40,404 in the U.S. Exclusive Economic Zone). All data associated with this expedition have been archived and are publicly available through the NOAA archives.

Region of Operation: Johnston Atoll

Ports: Hilo, Hawai'i, to Honolulu, Hawai'i

Bounding Coordinates: -173°, 17.5°, -154.5°, 21.5°

Expedition Dates: September 14-October 10, 2024

Expedition Type: Mapping

Theme Keywords: Beyond the Blue, Ocean Mapping, Exploration

Place Keywords: Johnston Atoll EEZ, Pacific Ocean, Hawai'i

Citation: Morrow, Thomas, Charlie Wilkins, Danielle Warren, and Amanda Bittinger. 2024. *Expedition Report: EX2406, Beyond the Blue: Johnston Atoll Mapping*. NOAA Ocean Exploration Expedition Rep. 24-06. NOAA Ocean Exploration, National Oceanic and Atmospheric Administration. United States. https://doi.org/10.25923/7vs2-zr57

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1. Introduction

NOAA Ocean Exploration is dedicated to exploring the unknown ocean, unlocking its potential through scientific discovery, technological advancements, and data delivery. By working closely with partners across public, private, and academic sectors, we are filling gaps in our basic understanding of the marine environment. This allows us, collectively, to protect ocean health, sustainably manage our marine resources, accelerate our national economy, better understand our changing environment, and enhance appreciation of the importance of the ocean in our everyday lives.

With priority placed on exploration of deep waters and the waters of the U.S. Exclusive Economic Zone (EEZ), NOAA Ocean Exploration applies the latest tools and technologies to explore previously unknown areas of the ocean, making discoveries of scientific, economic, and cultural value. By making collected data publicly available in increasingly innovative and accessible ways, we provide a unique and centralized national resource of critical ocean information. And, through live exploration video, online resources, training and educational opportunities, and public events, we share the excitement of ocean exploration with people around the world and inspire and engage the next generation of ocean scientists, engineers, and leaders.

NOAA Ocean Exploration uses NOAA Ship *Okeanos Explorer* to conduct much of this work. Data collected by NOAA Ocean Exploration on NOAA Ship *Okeanos Explorer* in Johnston Atoll will contribute to the *Beyond the Blue: Illuminating the Pacific* campaign; a multiyear, multipartner cooperative research and exploration campaign in U.S. and international waters throughout the remote Pacific Islands. Data and information collected during this campaign are intended to expand the footprint of coastal and ocean mapping, exploration, and characterization throughout the Pacific Islands region. Throughout the duration of *Beyond the Blue*, NOAA Ocean Exploration and campaign partners will work to create and maintain meaningful relationships to improve collaboration across the U.S. government, with local communities, and other stakeholders through thoughtful engagement, collaboration, and public-private partnerships. Building upon previous work in the region, including the 2015 - 2017 Campaign to Address Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE) and work sponsored by NOAA Ocean Exploration through the Ocean Exploration Cooperative Institute (OECI) and Ocean Exploration Trust, this campaign is intended to provide a foundation of publicly accessible information relevant to a variety of sectors and communities, all with the aim of building our collective knowledge of the Pacific Islands region.

NOAA Ocean Exploration's expeditions on *Okeanos Explorer* contribute to the National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone and Seabed 2030.

2. Expedition Overview

From September 14 to October 10, 2024, NOAA Ocean Exploration and partners conducted a telepresence-enabled ocean exploration expedition on *Okeanos Explorer* to collect critical baseline information and improve knowledge about unexplored and poorly understood deepwater areas of Johnston Atoll (EX2406). Previous expeditions in this region include KM1718, AVON01MV, KM2203, SKQ201402S, EX1607, EX1706, EX0909, KM1718, RR1609, EX1504L1, EX1504L4, KM1206, KM1206A, KM1209, KM1417, and NA141, KM1121.

During the 27 days at sea, 47,979 sq. km of bathymetric data were collected (see **Figure 1**). Section 5 provides details about the expedition schedule. A station log detailing the location of each operation conducted is provided as a supplemental file to this expedition report.

Figure 1. Map showing EX2406 bathymetric data collected around Johnston Atoll, part of the Pacific Remote Islands Marine National Monument. Depths are in meters.

Names, roles, and affiliations of science team members, both on ship and shore, are in **Appendix A**.

2.1 Rationale for Exploration

As part of the planning for this expedition, NOAA Ocean Exploration collaborated with the ocean science and management communities to assess exploration needs and data gaps in unknown and poorly known areas of Johnston Atoll. To define the operating area for this expedition, we considered the 2024 call for input and known priorities from resource managers.

The deepwater regions offshore Johnston Atoll are rich environments, home to deep-sea corals, chemosynthetic communities, and other sensitive habitats, as well as marine geohazards that threaten coastal communities with earthquakes, landslides, and tsunamis. Among these environments are vast energy resources in the form of seafloor minerals, wind, and waves.

Mapping and exploring these deep waters results in critical baseline information that can be integrated into Beyond the Blue campaign core datasets to help guide wise use of living marine resources and habitats, inform ocean energy and mineral resource decisions, and improve offshore natural hazard assessments.

Data and information from this expedition will inform deep-sea management plans for habitat areas of particular concern, marine protected areas, and national marine sanctuaries, support local scientists and managers seeking to understand and manage deep-sea resources, and stimulate subsequent exploration, research, and management activities.

This expedition contributed to ongoing collaborations with the NOAA Office of National Marine Sanctuaries, Pacific Islands Regional Office, and the Pacific Islands Fisheries Science Center.

2.2 Objectives

EX2406 addressed scientific themes and priority areas put forward by NOAA scientists and partners and the broad ocean science and management communities. The primary objective of the expedition was to explore deepwater areas in Johnston Atoll to provide baseline information to support science and management needs. Briefly, this expedition sought to:

- Collect high-resolution bathymetry in areas with no or low-quality mapping data.
- Map, survey, and sample geological features within Johnston Atoll to better understand the geological context of the region.
- Acquire a foundation of sonar and oceanographic data to better understand the characteristics of the water column and fauna that live there.
- Identify, map, and explore the diversity and distribution of benthic habitats, including fish habitats, deep-sea coral and sponge communities, chemosynthetic communities, and biological communities that colonize or aggregate around shipwrecks.
- Explore U.S. maritime heritage by identifying sonar anomalies as well as characterizing shipwrecks.
- Engage a broad spectrum of the scientific community and the public in telepresence-based exploration.
- Provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities.

A full list of expedition objectives is in "Project Instructions: EX2406, Beyond the Blue: Johnston Atoll Mapping 2" (Morrow, 2024).

3. Methodology

The primary systems used throughout EX2406 to accomplish objectives were:

- Sonar systems (Kongsberg EM 304 multibeam sonar, Knudsen 3260 sub-bottom profiler, Simrad EK60 and EK80 split-beam sonars, and Teledyne acoustic Doppler current profilers) to conduct seabed and water column mapping operations.
- A high-bandwidth satellite connection to provide real-time ship-to-shore communications (telepresence).

The following sections further detail the equipment and procedures used by NOAA Ocean Exploration during expeditions on *Okeanos Explorer*.

3.1 Acoustic Operations

Acoustic operations included Kongsberg EM 304 multibeam sonar, Simrad EK60 and EK80 split-beam sonar, Knudsen 3260 sub-bottom profiler, and acoustic Doppler current profiler (ADCP) data collection to map the seafloor, sub-seafloor, and water column, as well as to provide operational information for CTD casts. Standard survey operations include concurrent collection of multibeam, split-beam, and sub-bottom sonar data synchronized using a Kongsberg Synchronization Unit (K-Sync) with the EM 304 set as the master. The ADCPs were secured during standard surveying operations due to interference with other sonars, but were used to collect data when entering and exiting port.

Mapping operations were planned to maximize edge matching of existing data or to fill data gaps in areas with incomplete bathymetric coverage. In regions with no existing data, lines were optimized for potential discoveries and to complete relatively large continuous areas to support interpretation of features from bathymetry and backscatter. Targeted mapping operations were conducted near Johnston Atoll. Mapping operations occurred 24 hours/per day.

More information about general equipment calibration procedures, data collection, processing, reporting, and archiving is in the "NOAA Ocean Exploration Deepwater Exploration Mapping Procedures Manual" (Hoy et al. 2020).

3.1.1 Equipment and Data Collection Methods

Detailed descriptions of mapping equipment, annual calibrations, and capabilities on *Okeanos Explorer* are in the "NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report 2024"

[Candio et al, 2024]. Any deviations from the readiness report are noted in the following sections.

Supplemental files may be added to the readiness report throughout the year if changes to the equipment are made, such as mid-season calibrations. Users of mapping data from EX2406 should refer to the 2024 readiness report to see if any supplemental files report changes that may affect their analysis.

3.1.1.1 Multibeam Sonar

Okeanos Explorer is equipped with a 26 kHz Kongsberg EM 304 MKII multibeam sonar. The multibeam sonar was used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter. Bathymetric and seafloor backscatter data are stored in .kmall files as beam-averaged backscatter values and as full time-series values (snippets) within each beam. Water column backscatter data are stored separately in .kmwcd files.

Throughout the expedition, mapping watchstanders monitored multibeam data quality in real time by. Ship speed was adjusted to maintain data quality and sounding density as necessary, and line spacing was planned to ensure one-quarter to one-third swath-width overlap between lines, depending on the environmental conditions and impact on the quality of the outer swath regions. Maximum angles in the Seafloor Information System (SIS) were generally left open (75°/75°) during transit to maximize data collection and were adjusted on the port and starboard sides to ensure the best data quality and coverage. If outer beams were returning obviously spurious soundings (e.g., due to attenuation or low grazing angle), beam angles were gradually reduced and monitored closely until a high-quality swath was obtained. In the operating area, weather conditions frequently required significant overlap (up to 50%) of reciprocal lines to maintain coverage quality.

Real-time surface sound speed values were provided by a Reson SV70 sound velocity probe mounted in close proximity to the EM 304 transducer and were monitored in SIS for deviations from the values determined by sound speed casts. Sound speed profiles were collected every six hours or more frequently as dictated by local oceanographic conditions (typically every two hours when operating in more dynamic areas).

Vessel positioning and attitude was measured by Applanix POS MV V5 and Kongsberg Seapath 380 positioning systems during data collection. This redundancy allows for either system to be the primary source of positioning/attitude for the multibeam data in the event that one of them fails. Positioning/attitude data were applied to the multibeam data in real time and were stored in .kmall files. The primary system used is noted in the processing logs.

Background data used to guide multibeam mapping operations included expeditions KM1718, AVON01MV, KM2203, SKQ201402S, EX1607, EX1706, EX0909, KM1718, RR1609, EX1504L1, EX1504L4, KM1206, KM1206A, KM1209, KM1417, and NA141, KM1121.

3.1.1.2 Sub-Bottom Profiler

Okeanos Explorer is equipped with a Knudsen 3260 sub-bottom profiler with a central frequency of 3.5 kHz. This sonar was used to collect echogram images of shallow geological layers underneath the seafloor to a maximum depth of approximately 80 m below the seafloor. Phase, range, and gain were monitored and optimized for data collection. New files were created when changes were made to pulse lengths and/or power settings.

3.1.1.3 Split-Beam Sonars

Okeanos Explorer is equipped with a suite of five Simrad EK60 and EK80 split-beam sonars: three general purpose transceivers (GBTs), the 18, 120, and 200 kHz sonars, and two wide-band transceivers (WBTs), the 38 and 70 kHz sonars. These quantitative scientific echosounders were calibrated to identify the target strength of water column acoustic reflectors (e.g., deep scattering layers, fish, gas bubbles from seeps), providing additional information about water column characteristics and anomalies.

Calibrations were performed during EX2401, and these calibration values were most appropriate for the EX2406 dataset. The calibration files are archived with the sonar data, and the calibration report is available as a supplemental file to the 2024 mapping readiness report (Candio et al., 2024). The split-beam sonars were used continuously throughout EX2403 during mapping operations and CTD operations.

3.1.1.4 Acoustic Doppler Current Profiler

Okeanos Explorer is equipped with two acoustic Doppler current profilers (ADCPs), a Teledyne Workhorse Mariner (300 kHz) and a Teledyne Ocean Surveyor (38 kHz). Depending on environmental conditions, the 300 kHz system provides ocean current data to a depth of approximately 70 m, and the 38 kHz system provides data to a depth of approximately 1,200 m.

3.1.2 Data Processing and Quality Assessment Methods

3.1.2.1 Multibeam Sonar Bathymetry and Seabed Backscatter

Full-resolution multibeam files (.kmall) were imported into QPS Qimera and then processed and cleaned of noise and artifacts. Outlier soundings were removed using multiple methods, including automatic filtering and/or manual cleaning with the swath and subset editing tools. The default sound speed scheduling method used was “Nearest-in-Time.” If another method was used, it was noted in the multibeam processing log that is archived with the dataset.

Gridded digital terrain models were created using the weighted moving average algorithm and were exported in multiple formats using QPS Fledermaus. Daily bathymetric surfaces were created and sent to shore.

A final quality check of the data was performed on shore prior to submission to the archive. This involved additional fine cleaning of soundings and minimization of residual artifacts from sound speed biases and field-cleaning errors. Depth values were compared against orthogonal lines (crosslines) to evaluate the consistency of the multibeam sonar data collected during the expedition (**Figure 2**). A crossline analysis was completed using the Crosscheck Tool in QPS Qimera (**Table 1**) to evaluate the data against the Order 1 S-44 standards set by the International Hydrographic Organization (IHO 2008).

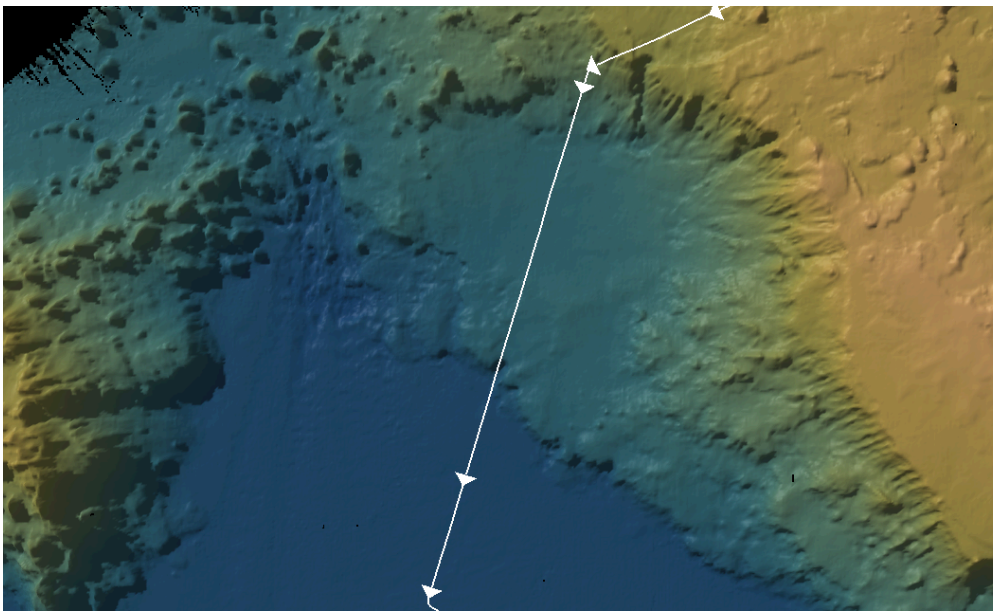

Figure 2. EX2406 crossline (shown in yellow) used for comparison against the bathymetric grid generated via orthogonal multibeam survey lines. Depth areas are displayed in meters.

Crossline files:

0404_20240927_183905_EX2406_MB.kmall

0405_20240927_193905_EX2406_MB.kmall

Table 1. Crosscheck results.

Statistic	Value
Number of Points of Comparison	275206

Statistic	Value
Grid Cell Size (m)	100
Difference Mean (m)	0.4044
Difference Median (m)	0.4044
Difference Standard Deviation (m)	4.9445
Difference Range (m)	[-73.64, 81.62]
Mean + 2* Standard Deviation (m)	10.293507
Median + 2* Standard Deviation (m)	10.293507
Data Mean (m)	-4570.700298
Reference Mean (m)	-4571.104702
Data Z-Range (m)	[-5062.15, -3799.83]
Reference Z-Range (m)	[-5014.03, -3807.43]
Order 1 Error Limit (m)	59.424889
Order 1 # Rejected	15
Order 1 P-Statistic	0.000055
Order 1 Survey	ACCEPTED

The results in **Table 1** confirm that the data collected meet International Hydrographic Organization Order 1 specifications for data quality.

Each line of cleaned full-resolution data was exported to a .gsf file (Level-01 data). The processed and cleaned files were used to create a static surface in QPS Qimera. This final surface was re-projected to the field geographic WGS84 reference frame in QPS Fledermaus and saved as an .sd file for archiving. Using QPS Fledermaus, this .sd bathymetric grid file was then exported as ASCII .xyz, color .tif, floating point .tif, and Google Earth .kmz files. The .gsf files were used to create daily backscatter mosaics using QPS Fledermaus FMGT.

All products maintain horizontal referencing to WGS84 (G1762) and vertical referencing to the assumed mean waterline (based on the waterline measured during the annual shakedown expedition). The draft values for *Okeanos Explorer* used during the expedition are in **Table 2** for the purpose of further post-processing, if desired by the user. Positioning data files for post-processing be requested by sending an email to ex.expeditioncoordinator@noaa.gov.

Table 2. *Okeanos Explorer*'s draft at the beginning and end of EX2406.

Location	Start of Expedition (09/14/2024)	End of Expedition (10/10/2024)
Forward	14' 6''	13' 11''
Aft Starboard	14' 5.5''	13' 9.5''
Aft Port	14' 6.5''	14' 11.5''

3.1.2.2 Multibeam Sonar — Water Column

EM 304 water column files (.kmwcd) were reviewed in QPS FM Midwater or Qimera for anomalies (e.g., gas seeps and hydrothermal plumes). No anomalies were observed during this expedition.

3.1.2.3 Split-Beam Sonars

No anomalies were observed during this expedition.

Calibration reports and files are archived with the split-beam data.

3.1.2.4 Sub-Bottom Profiler

Using Natural Resources Canada's SEGYJp2 software, the raw files (.sgy) from the sub-bottom profiler 3 were processed for gain to produce the clearest image of sub-bottom layers. The gain processed files were converted to jpeg images (.jpg) and shapefile tracklines (.shp).

3.1.2.5 Sound Speed

Raw sound speed profiles collected from expendable bathythermographs (XBTs) were processed using HydrOffice Sound Speed Manager and archived as .asvp files.

3.1.3 Data Collection and Processing Software

Table 3 provides a list of the data collection and processing software versions used during EX2406.

Table 3. Versions of data collection and processing software used during EX2406.

Software	Purpose	Version
SIS	EM 304	5.12.2
EK80	EK suite	2.0.0
EchoControl	Knudsen	4.09
UHDAS	ADCPs	14.04

Software	Purpose	Version
AMVERSEAS	Autolaunch XBT	9.3.6
WinMK21	XBT	3.0.2
K-Sync	Synchronization	1.9.0
Qimera	Bathymetry	2.6.3
FMGT	Backscatter	7.11.1
FM Midwater	Water Column	7.9.5
Sound Speed Manager	Sound Speed Profiles	2024.0.3
NRCan (SegJp2)	Sub-Bottom	1.0
Fledermaus 7	Visualization/Data Analysis	7.8.11

3.3 Sun Photometer Measurements

NOAA Ocean Exploration gathers limited at-sea measurements aboard *Okeanos Explorer* to support a NASA-led, long-term research effort that assesses marine aerosols. As time allowed on cloud-free days, onboard personnel collected georeferenced sun photometer measurements for the Maritime Aerosol Network (MAN) component of the Aerosol Robotic Network (AERONET). AERONET is a network of sun photometers that measure atmospheric aerosol properties around the world. MAN complements AERONET by conducting sun photometer measurements on ships of opportunity to monitor aerosol properties over the global ocean.

4. Environmental and Historical Compliance

Overviews of expedition-specific compliance activities are provided below. Copies of associated records of compliance are in **Appendix B**.

4.1 Environmental Compliance

Pursuant to the National Environmental Policy Act (NEPA), NOAA Ocean Exploration is required to include in its planning and decision-making processes appropriate and careful consideration of the potential environmental consequences of actions it proposes to fund, authorize, and/or conduct. The companion manual (NOAA 2017) for NOAA Administrative Order 216-6A: Compliance with the National Environmental Policy Act, et al. describes the agency's specific procedures for NEPA compliance.

An environmental review memorandum was completed for all *Okeanos Explorer* expeditions in 2024 in accordance with Section 4 of the companion manual in the form of a categorical exclusion worksheet. Based on this review, a categorical exclusion was determined to be the

appropriate level of NEPA analysis necessary, as no extraordinary circumstances existed that required the preparation of an environmental assessment or environmental impact statement. NOAA Ocean Exploration is preparing a programmatic environmental assessment to cover future expeditions.

5. Schedule

Table 4 provides a day by day breakdown of EX2406.

Table 4. EX2406 schedule.

Date (UTC)	Activity
9/14	Mobilization at Hilo, Hawai'i
9/15	Departure, transit mapping to target field location near Johnston Atoll
9/16	Transit mapping
9/17	Transit mapping
9/18	Transit mapping
9/19	Focused mapping in the target area near Johnston Atoll
9/20	Focused mapping in the target area near Johnston Atoll
9/21	Focused mapping in the target area near Johnston Atoll
9/22	Focused mapping in the target area near Johnston Atoll
9/23	Focused mapping in the target area near Johnston Atoll
9/24	Focused mapping in the target area near Johnston Atoll
9/25	Focused mapping in the target area near Johnston Atoll
9/26	Focused mapping in the target area near Johnston Atoll
9/27	Focused mapping in the target area near Johnston Atoll
9/28	Focused mapping in the target area near Johnston Atoll
9/29	Focused mapping in the target area near Johnston Atoll
9/30	Focused mapping in the target area near Johnston Atoll
10/1	Focused mapping in the target area near Johnston Atoll
10/2	Focused mapping in the target area near Johnston Atoll; outreach: live interaction with McKinzey Middle School STEM Academy
10/3	Focused mapping in the target area near Johnston Atoll
10/4	Focused mapping in the target area near Johnston Atoll; outreach: live interaction with North County High School

Date (UTC)	Activity
10/5	Focused mapping in the target area near Johnston Atoll; outreach: live interaction with Knox Neighborhood Community
10/6	Finished up focused area mapping and filling in several mapping gaps in data and began transit mapping back to Honolulu
10/7	Transit mapping back to Honolulu
10/8	Transit mapping back to Honolulu
10/9	Transit mapping back to Honolulu
10/10	Arrival in Ford Island, Honolulu and demobilization

6. Results

This section details the results of EX2406. Metrics for the expedition's major scientific work are in **Table 5**. A station log detailing the location of each operation conducted is provided as a supplemental file to this expedition report.

Table 5. Summary of scientific metrics for EX2406.

Metrics	Totals
Days at Sea	27
Days at Sea in U.S. Waters	27
Linear km Mapped by EM 304	7463
Sq. km Mapped by EM 304	47,979
Sq. km Mapped by EM 304 in U.S. Waters >200m	40,404
eDNA Water Samples	0
Ship CTD Casts	0
XBT Casts	90

* Organisms unknown to science or an extension of their known range of geolocation or depth

6.1 Acoustic Operations Results

NOAA Ocean Exploration mapped 47,9791 sq. km of seafloor during the 27 days at sea for EX2406. Of the 47,979 sq. km mapped, 40,404sq. km was deeper than 200 m and within the U.S. Exclusive Economic Zone and Territorial Sea.

Acoustic mapping data are sent to the NOAA archives within 120 days of the end of an expedition. The 2024 mapping readiness report describes the data archived for each dataset, including file formats [Candio et al., 2024]. Information about proprietary software and

freeware that can handle the varying data types is in the "NOAA OER Deepwater Exploration Mapping Procedures Manual" (Hoy et al. 2020). **Appendix C** provides excerpts about mapping operations from daily situation reports to provide situational awareness for future users of the data collected during EX2406.

6.2 Sampling Operations Results

There were no water samples collected for eDNA analysis.

6.3 Novel Technologies and Opportunistic Tools

No novel technologies or opportunistic tools were used during EX2406.

6.4 Engagement

EX2406 engaged with audiences around the world, opening a window of understanding into the deep sea. Highlights:

- Live video feeds received over 15,600 views, and web content received 800 page views during EX2406.
- Three live interactions engaging with 61 K-12 students occurred during EX2406.

7. Data Access

All data collected during NOAA Ocean Exploration expeditions and associated products are made publicly available via the NOAA archives, NOAA's National Centers for Environmental Information (NCEI), the NOAA Institutional Repository, and the Smithsonian National Museum of Natural History and Oregon State University sample repositories, unless protected (e.g., data associated with specific maritime heritage sites). Data collected by NOAA must be covered by a data management plan to ensure they are archived and publicly accessible. The data management plan for EX2406 is in the "Project Instructions: Beyond the Blue: Johnston Atoll Mapping 2" (Morrow, 2024).

The primary tools for accessing data collected during this expedition and archived at NCEI are the EX2406 data landing page, the NOAA Ocean Exploration Data Atlas, and the NOAA Ocean Exploration Video Portal (video data was not collected during EX2406). Refer to the NOAA Ocean Exploration Data Access web pages for help navigating expedition data. Other resources include the NOAA Ocean Exploration Data (NCEI) ArcGIS online group, which provides access to all NOAA Ocean Exploration geospatial data services managed by NCEI, including the geospatial

data layers found in the data atlas, and the NOAA Ocean Exploration Data Management website.

NCEI makes data publicly available over time as quality-control measures are completed, data are released, and publications and related materials are published. Thus, not all data and products will be made available at the same time. To access data and products from EX2406 that aren't yet public, request assistance by submitting a data request form or sending an email to oer.info.mgmt@noaa.gov.

7.1 Digital Data/Product Locations

The locations for directly accessing specific types of digital data collected during EX2406 and products documenting expedition results (at the time of writing this report) are provided in **Table 6**.

Table 6. Online locations for direct access to digital data collected during EX2406 and products documenting expedition results (at the time of writing this report).

Data/Product Type	Description
EM 304 Bathymetry and Backscatter Data	EM 304 bathymetric and backscatter data, supporting informational logs, and ancillary files are available through NCEI's Bathymetric Data Viewer POSPac and BS correction files can be requested from oar.oer.exmappingteam@noaa.gov
Water Column Data (EM 304 and EK60/EK80)	EM 304 and EK60/EK80 water column data, supporting data, and informational logs are available through NCEI's Water Column Sonar Data Viewer
Knudsen 3260 Sub-Bottom Profiler Data	Sub-bottom data, supporting data, and informational logs are available in NCEI's Trackline Geophysical Data Viewer
ADCP Data	ADCP raw data are available through the NCEI Global Ocean Currents Database
Sound Speed Profiles	Ancillary sound speed profiles are available with the mapping data through NCEI's Bathymetric Data Viewer and the expedition's oceanographic dataset

Data/Product Type	Description
Oceanographic Dataset	Oceanographic data and products are available from NCEI. These data include data from shipboard sensors, including navigational data, meteorological data (wind), and oceanographic data (bathythermograph, sound velocity probe, thermosalinograph); additional data and products include profile data (CTD and XBT), event logs, images, ROV ancillary data, and sample data
Sun Photometer Measurements	Sun photometer measurements are available through NASA's Marine Aerosol Network
Reports and Papers	Reports and peer-reviewed papers are available through the NOAA Ocean Exploration Library Guide and the NOAA Institutional Repository

References

Candio, Sam, Patricia Albano, Charlie Wilkins, Anna Coulson, and Jason Meyer. 2024. *2024 NOAA Ship Okeanos Explorer Mapping Systems Readiness Report*. NOAA Ocean Exploration, National Oceanic and Atmospheric Administration. United States. https://doi.org/10.25923/j7ab-w612.

Morrow, Thomas. 2024. *EX2406 Project Instructions: Beyond the Blue: Johnston Atoll Mapping 2*. NOAA Ocean Exploration, National Oceanic and Atmospheric Administration. United States. https://repository.library.noaa.gov/view/noaa/70296.

Hoy, Shannon, Elizabeth Lobecker, Sam Candio, Derek Sowers, Grant Froelich, Kevin Jerram, Rachel Medley, Mashkoor Malik, Adrienne Copeland, Kasey Cantwell, Charlie Wilkins, and Amanada Maxon. (2020). *Deepwater Exploration Mapping Procedures Manual*. NOAA Ocean Exploration, National Oceanic and Atmospheric Administration. United States. https://doi.org/10.25923/jw71-ga98.

IOCM (Interagency Working Group on Ocean and Coastal Mapping). 2024. *Progress Report on Unmapped U.S. Waters*. https://iocm.noaa.gov/documents/mapping-progress-report2024.pdf.

IHO (International Hydrographic Organization). 2008. *IHO Standards for Hydrographic Surveys*, 5th edition. International Hydrographic Bureau. International Hydrographic Organization Special Publication, S-44. https://iho.int/uploads/user/pubs/standards/s-44/S-44_5E.pdf.

Kennedy, Brian R.C., Kasey Cantwell, Mashkoor Malik, Christopher Kelley, Jeremy Potter, Kelly Elliott, Elizabeth Lobecker, Lindsay McKenna Gray, Derek Sowers, Michael P. White, Scott C. France, Stephen Auscavitch, Christopher Mah, Virginia Moriwake, Sarah R.D. Bingo, Meagan Putts, and Randi D. Rotjan. 2019. "The unknown and the unexplored: Insights into the Pacific

deep-sea following NOAA CAPSTONE expeditions." *Frontiers in Marine Science* 6:480. https://doi.org/10.3389/fmars.2019.00480.

NOAA (National Oceanic and Atmospheric Administration). 2017. *Policy and Procedures for Compliance with the National Environmental Policy Act and Related Authorities*. NOAA. United States. https://www.noaa.gov/sites/default/files/2021-10/NOAA-NAO-216-6A-Companion-Manual-03012018%20%281%29.pdf.

Quattrini, Martha S. Nizinski, Jason D. Chaytor, Amanda W. J. Demopoulos, E. Brendan Roark, Scott C. France, Jon A. Moore, Taylor Heyl, Peter J. Auster, Brian Kinlan, Carolyn Ruppel, Kelley P. Elliott, Brian R.C. Kennedy, Elizabeth Lobecker, Adam Skarke, and Timothy M. Shank. 2015. "Exploration of the canyon-incised continental margin of the northeastern United States reveals dynamic habitats and diverse communities." *PLoS One* 10:e0139904. https://doi.org/10.1371/journal.pone.0139904.

Ryan, William B.F., Suzanne M. Carbotte, Justin O. Coplan, Suzanne O'Hara, Andrew Melkonian, Robert Arko, Rose Anne Weissel, Vicki Ferrini, Andrew Goodwillie, Frank Nitsche, Juliet Bonczkowski, Richard Zemsky. 2009. "Global Multi-Resolution Topography (GMRT) synthesis data set." *Geochemistry, Geophysics Geosystems* 10(3): Q03014. https://doi.org/10.1029/2008GC002332.

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2001. Convention for the Protection of the Underwater Cultural Heritage. UNESCO. France. https://unesdoc.unesco.org/ark:/48223/pf0000126065.

Appendix A: EX2406 Science Team Members

EX2406 included onboard mission personnel (**Table A1**) as well as shore-based science personnel (**Table A2**) who participated remotely via telepresence.

Table A1. EX2406 onboard mission team personnel.

Name	Role	Affiliation
Morrow, Thomas	Expedition Coordinator	NOAA Ocean Exploration
Bittinger, Amanda	Mapping Watch Lead	University Corporation for Atmospheric Research
Warren, Danielle	Mapping Watch Lead	NOAA Ocean Exploration/University Corporation for Atmospheric Research
Wright, Chris	Data Manager	Global Foundation for Ocean Exploration
Brian, Roland	Video Engineer	Global Foundation for Ocean Exploration
Doros, Brian	Video Engineer	Global Foundation for Ocean Exploration
Howard, Art	Videographer	Global Foundation for Ocean Exploration
Gwinn, Jessica	Internship Coordinator	NOAA Ocean Exploration/University Corporation for Atmospheric Research
Norstad, Abigail	Explorer-in-Training	University Corporation for Atmospheric Research
Mathis, Nathanael	Explorer-in-Training	University Corporation for Atmospheric Research
Knox, Gina	Explorer-in-Training	University Corporation for Atmospheric Research

Appendix B: EX2406 Environmental and Historical Compliance Documentation

The following documents pertaining to environmental and historical compliance are attached as supplements:

1. Essential fish habitat (EFH) consultation response dated April 1, 2024

Essential fish habitat (EFH) consultation response dated April 1, 2024

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1845 Wasp Blvd., Bldg 176
Honolulu, Hawai'i 96818

(808) 725-5000 · Fax: (808) 725-5215

Jennifer Lukens
Deputy Director
National Oceanic and Atmospheric Administration
Office of Ocean Exploration and Research
Silver Springs, MD 20910

April 1, 2024

Dear: Dr. Lukens:

The National Marine Fisheries Service, Pacific Islands Regional Office (NMFS) received a request for an essential fish habitat (EFH) consultation on March 14, 2024 from NOAA's Office of Exploration and Research (OER) for the "Beyond the Blue" campaign, the fisheries and ecosystem research that OER will conduct and/or fund from 2024 – 2026 across the Pacific region. OER has proposed to include and adhere to best management practices (BMPs) and minimization measures that when implemented would be suitable to ensure that adverse effects to EFH would be minimal. NMFS appreciates the opportunity to review the proposed permit action pursuant to the EFH provisions (Section 305(b) as described by 50 CFR 600.920) of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act; 16 U.S.C. 1855(b)). After reviewing the consultation enclosures, we have determined that there may be adverse effects to EFH. We provide conservation recommendations under the EFH provisions within Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) to help the permit applicant to avoid and minimize adverse effects to EFH.

Project Description

OER's proposed marine operation activities are intended to support initiatives including the Seabed 2030 and the National Strategy for Ocean Mapping, Exploration, and Characterization. To support these initiatives, the focus of the "Beyond the Blue" campaign will be to fill the gaps in basic understanding of deep-ocean and seafloor data, information, and overall awareness within the U.S. Exclusive Economic Zone (EEZ) and international waters. Work is expected to commence in the Pacific Ocean starting in April 2024, and extend through to December 2026.

Expeditions will be conducted primarily on *Okeanos Explorer*, *Nautilus,* and other vessels of similar or smaller size. Activities will be funded by OER and will provide real-time or near real-time, open access deep-water oceanographic data that would benefit NOAA, research and education institutions, resource managers, and the general public. These same technologies are also used on other OER supported projects and oceanographic research platforms.

Okeanos Explorer conducts four types of expeditions annually:

1. Mapping survey expeditions: These expeditions conduct 24/7 seafloor mapping using hull mounted sonars, and conductivity-temperature-density (CTD) rosette casts. Additional technologies are occasionally brought on board to acquire more data in the area of interest;

2. Telepresence-enabled remotely operated vehicle(s) (ROV), uncrewed surface vessel(s) (USV), and autonomous underwater vehicle(s) (AUV) expeditions. During these expeditions, ROV, USVs, and AUVs dives or deployments are conducted for several hours to several days. When the ROV is not in the water, the ship conducts mapping and occasional CTD rosette casts;

3. Shakedown expeditions: These expeditions are to test mapping capabilities; ROV, USV, AUV, and CTD systems; and

4. Technology Testing Expeditions: These expeditions are planned to test novel and emerging technologies.

E/V *Nautilus* conducts very similar cruise types to those above, however more frequently deploys additional scientific equipment including human occupied vehicles, profilers, landers, profiling floats, and other cabled equipment. Other research vessels also conduct these same activities, however, most are not equipped with telepresence technology.

On average each year, approximately five *Okeanos Explorer* expeditions are dedicated to mapping, while up to four expeditions combine ROV, and/or USVs and AUVs work and overnight mapping. The duration of these expeditions typically range from 7 to 30 days. Shakedown and emerging technology expeditions range from 7 to 30 days in duration. In addition, OER-supported expeditions may be conducted based on available funding and vessel(s) availability.

OER also occasionally supports USV operations that are either dedicated missions deployed from shore, or deployed from a ship. Several of these deployments may be supported by OER each year and each deployment ranges from 1 to 60 days.

Proposed Action Area

The proposed activities will be conducted in unknown and poorly known marine environments around the Central, Southern, Eastern, and Western Pacific Ocean in depths of 656 feet (200 meters) and deeper, and the areas transited by vessels between ports, including but not limited to ports of calls located in North America and the Pacific Islands. Transit mapping operations are also planned between all areas mentioned, including the high seas.

In the Pacific Islands and Central Pacific, NOAA OER will primarily target areas with lower percentage of mapping coverage. Complementary exploration opportunities, activities and operations conducted by partners but funded by OER, will include systematic mapping in Howland/Baker, Jarvis, Wake Island, Johnston Atoll, and American Samoa. Focal areas for the *Okeanos Explorer* are expected to include Kingman and Palmyra and Johnston Atoll, and deep waters surrounding the Northwest Hawaiian Islands and along the Emperor Seamount chain.

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Essential Fish Habitat

Pelagic FEP

The marine water column extending from the surface to a depth of 656 feet (200 meters) from the shoreline to the outer limit of the EEZ for eggs and larvae, and to a depth of 3,280 feet (1,000 meters) for adults, in the pelagic environment have been designated as EFH under the Western Pacific Fishery Management Council's Pelagic Fishery Ecosystem Plan.

Pacific Remote Island Area

The marine water column from the surface to a depth of 3,280 feet (1,000 meters) from the shoreline to the outer boundary of the EEZ (230 miles), and the seafloor from the shoreline out to a depth of 328 feet (100 meters) around the islands and atolls of the Pacific Remote Islands, have been designated as EFH. As such, the water column and submerged bottom habitats of around each of the Pacific Remote Island Areas are designated as EFH and support various life stages for the management unit species (MUS) identified under the Western Pacific Fishery Management Council's Pacific Remote Island Areas Fishery Ecosystem Plan (FEP). The MUS and life stages found in these waters include: eggs, larvae, juveniles, and adults of Coral Reef Ecosystem MUS, Bottomfish MUS (BMUS), and Crustacean MUS (CMUS); and juveniles and adults of Pelagic MUS (PMUS).

Mariana Archipelago

The marine water column from the surface to a depth of 3,280 feet (1,000 meters) from shoreline to the outer boundary of the EEZ, and the seafloor from the shoreline out to a depth of 1,313 feet (400 meters) around each of the Mariana Islands, have been designated as EFH. As such, those waters are designated as EFH and support various life stages for the MUS identified under the Western Pacific Fishery Management Council's Mariana Archipelago Fishery Ecosystem Plan. The MUS and life stages may include eggs, larvae, juveniles, and adults for BMUS, PMUS, and CMUS.

Hawai'i Archipelago

The marine water column from the surface to a depth of 3,280 feet (1,000 meters) from shoreline to the outer boundary of the EEZ, and the seafloor from the shoreline out to a depth of 2,296 feet (700 meters) around each of the Hawaiian Islands, have been designated as EFH. As such, the water column and bottom of the Pacific Ocean near each of the islands and atoll of the

Northwestern Hawaiian Islands, and the surrounding waters and submerged lands are designated as EFH and support various life stages for the MUS identified under the Western Pacific Fishery Management Council's Hawai'i Archipelago FEP. The MUS and life stages found in these waters include larvae, juveniles, and adults of BMUS, PMUS, and CMUS.

American Samoa Archipelago

The marine water column extending from the surface to a depth of 3,280 feet (1,000 meters) from the shoreline to the outer limit of the EEZ, and the seafloor to a depth of 1,313 feet around the islands of American Samoa have been designated as EFH. As such, the water column and bottom of the nearshore Pacific Ocean surrounding the islands and atolls in American Samoa are designated as EFH and support variouslife stages for the MUS identified under the Western Pacific

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Fishery Management Council's American Samoa Archipelago FEP. The MUS and life stages found in these waters include: eggs, larvae, juveniles, and adults of BMUS.

Specific types of habitat considered as EFH for the all of the above FEPs include coral reef, patch reef, hard substrate, artificial substrate, seagrass beds, soft substrate, lagoon, estuarine, surge zone, deep slope terraces and pelagic/open ocean.

Potential Adverse Effects

There is the potential for adverse effects to EFH due to vessel transits (including tender boats), from the deployment and recovery of instruments (including ROVs, USVs, etc.), and the collection of biological and geological samples. Adverse effects may be a result of physical damage, turbidity, chemical contamination, and the introduction of invasive species.

Physical Damage/Removal (physical stressor): Physical damage to principle benthic organisms may result in breakage or dislocation (i.e., mortality). Corals are particularly vulnerable to physical damage because their slow-growing carbonate skeleton is relatively brittle and their polyps are easily damaged. Reduction of topographic complexity in the habitats of the coral reef ecosystem reduces biodiversity and productivity (Alvarez-Filip et al. 2009). Literature reviews (Newell et al., 1998; ICES 2016) suggest that the successional marine community requires at least six to eight months to recover back to initial levels after removal.

Turbidity: Increased turbidity can cause smothering of benthic species and block sunlight necessary for species that rely on photosynthesis. For corals, turbidity has been shown to reduce species diversity, change growth patterns, and reduce growth and survival (Rogers 1990). For fish, turbidity is less likely to cause significant impacts because of their mobility, but some effects are still possible. Fish may be displaced from their normal home range which could result in negative intra- and interspecies interactions and impact fitness, leading to lower reproductive success and a lower ability to find prey or avoid predators (Kjelland et al. 2015).

Chemical Contamination (pollution stressor): Chemical pollutants can have a variety of lethal and sublethal effects on habitat-forming marine organisms, including alteration of growth, interference with reproduction, disruption of metabolic processes, and changes in behavior. These adverse effects can cascade through ecosystems, altering species composition and ecosystem functions and services. Some pollutants are environmentally persistent and can take years or even decades to biodegrade, and others can bioaccumulate or biomagnify through the

food chain, eventually posing a direct threat to human health. Petroleum contamination can adversely affect coral, with results including mortality, inhibition of reproduction, reduced calcium deposition, alteration of physiological processes, tissue loss, and reduced carbon fixation (Turner and Renegar 2017).

Introduction of invasive species (biological stressor): Introduced species are organisms that have been moved, intentionally or unintentionally, into areas where they do not naturally occur. Invasive species may rapidly increase in abundance to the point that they come to dominate their new environment, creating adverse ecological effects to other species of the ecosystem and the functions and services it may provide (Goldberg and Wilkinson 2004). Invasive species can decrease species diversity, change trophic structure, and diminish physical structure, but adverse effects are highly variable and species-specific.

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OER-proposed BMPs

Physical impact to benthic habitat

- All vessels in coastal waters will operate in a manner to minimize propeller wash and seafloor disturbance, and transiting vessels should follow deep water routes, as practicable.
- Except in an emergency, the vessel will not anchor while at sea.
- Vessels will avoid anchoring on hard-bottom and coral habitat.
- Vessels will avoid anchoring in areas containing seagrass or eelgrass.

Turbidity

- Whenever possible, cabled instruments deployed will not be allowed to contact the seafloor. Those that do contact the seafloor will only do so for the minimal time required to achieve scientific objectives.
- The vessel will employ the use of dynamic positioning during ROV dives, or other vehicle/instrument operations that would otherwise require anchoring.
- Vehicles/instruments will be operated in a manner to avoid seafloor disturbance, and setting the vehicles/instruments on the seafloor will be held to a minimum. For those situations when the vehicle/instrument does make contact with the seafloor, visual observations will be made to confirm that the area the vehicle/instrument is set down on does not include corals or other fragile animals that can reasonably be avoided.
- When possible, rock samples will be selected in a way to minimize disturbance to the surrounding environment and to minimize the take of attached organisms.
- Landers will not be deployed in, or adjacent to, areas with benthic environments designated as EFH or Habitat Areas of Particular Concern (HAPC).
- OER will not conduct operations with these types of bottom-impacting AUVs in designated EFH and HAPC

Introduction of invasive species

- Avoid discharge of ballast water in designated protected habitats.
- All vessels will use anti-fouling coatings.
- Clean hull regularly to remove aquatic nuisance species.
- Avoid cleaning of hull in protected habitats.
- After each instrument/vehicle is used, the vehicles/instruments will be brought back onboard and thoroughly sprayed with freshwater and allowed to air dry before the next dive. Though marine organisms should not survive this process, the instruments/vehicles are thoroughly inspected prior to every dive and checked for the presence of biological organisms to prevent the spread of invasive species from one location to another.

Vessel waste and discharge

- All vessels operating in areas where protected habitats are known to be present in the region will continue to follow the International Convention for the Prevention of Pollution from Ships discharge protocols.

- The use of detergents and other pollutants which may be washed into the marine environment will be avoided or held to a minimum.
- Avoid use of cleaners with nonylphenols.

OER Determination

OER has determined that implementation of the various BMPs listed above during the 2024 – 2026 fisheries and ecosystem research conducted and/or funded by OER will be sufficient to avoid or minimize adverse effects to EFH. OER seeks NMFS concurrence with this determination.

NMFS Concerns

NMFS expects that many potential adverse effects from the "Beyond the Blue" campaign will be reduced when implementing the OER-imposed BMPs. However, NMFS remains concerned that there is a risk of unavoidable loss of EFH due to the potential degradation of the quality of EFH from direct physical impacts from the potential use of anchors. To further avoid and minimize the risk to EFH in the project area, NMFS offers the conservation recommendations below.

Conservation Recommendations

NMFS offers the following conservation recommendation to the OER pursuant to 50 CFR 600.920 so that potential adverse effects from the proposed project activities are avoided, minimized, offset for, or otherwise mitigated:

Conservation Recommendation 1: Inspect all equipment prior to beginning work each day to ensure the equipment is in good working condition, and there are no contaminant (e.g., oil, fuel)

leaks. Work must be stopped until leaks are repaired and equipment is cleaned.

Conservation Recommendation 2: All AUV and submersible missions will have a plan that details the mission, geographic locations, and deployment and retrieval plans to minimize the potential for collisions and groundings and ensure proper retrieval.

Conservation Recommendation 3: As possible, a spill response kit should be kept on all boats while in operation in order to be able to respond rapidly in the event of a spill (gas, oil, etc.).

Conclusion

Please be advised that regulations (Section 305(b)(4)(B)) to implement the EFH provisions of the Magnuson-Stevens Act require that federal activities agencies provide a written response to this letter within 30 days of its receipt and at least 10 days prior to final approval of the activities. A preliminary response is acceptable if final activities cannot be completed within 30 days. The final response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the activity. If the response is inconsistent with our EFH Conservation Recommendations, an explanation of the reason for not implementing the recommendations must be provided.

NMFS greatly appreciates the OER' efforts to comply with the EFH provisions of the Magnuson Stevens Act for the proposed Jarvis Island project. NMFS has determined that while the OER' proposed mitigation measures will help to avoid and minimize adverse effects to EFH, some unavoidable loss may still occur. NMFS provides the EFH conservation recommendation as described above to help OERS ensure that adverse effects to EFH included coral reef resources are avoided, minimized, offset for, or otherwise mitigated.

Please do not hesitate to contact Richard Hall at 808-725-5018 and or richard.hall@noaa.gov should you have any questions, comments, or require additional technical assistance.

Sincerely,

Gerry Davis Assistant Regional Administrator
Habitat Conservation Division

cc by e-mail: Kelly Suhre, NOAA OER
Amanda Maxon, NOAA OER
Malia Chow, NOAA NMFS PIRO HCD
David Delaney, NOAA NMFS PIRO HCD
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Richard Hall, NOAA NMFS PIRO HCD

References Cited

Alvarez-Filip, L., Dulvy N., Gill J., Côté I., and A. Watkinson. 2009. Flattening of Caribbean coral reefs: Region-wide declines in architectural complexity. Proceedings of the Royal Society B: Biological Sciences. 276(1669):3019-3025.

Goldberg, J. and C. Wilkenson. 2004. Global threats to coral reefs: coral bleaching, global climate change, disease, predator plagues, and invasive species. In Status of the Coral Reefs of the World: 2004 (C. Wilkinson, ed.). Australian Institute of Marine Science, Townsville, Queensland. pp. 67-92.

ICES. 2016. Effects of extraction of marine sediments on the marine environment 2005–2011. ICES Cooperative Research Report No. 330. 206 pp.

Kjelland, M., Woodley C., Swannack T., and D. Smith. 2015. A review of the potential effects of suspended sediment on fishes: potential dredging-related physiological, behavioral, and transgenerational implications. Environ. Syst. Decis. 35:334-50.

Newell, R.C., Seiderer, L.J. and D.R. Hitchcock. 1998. The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. Oceanography and Marine Biology: An Annual Review, 36, pp.127- 178.

Renegar, D. 2017. Petroleum hydrocarbon toxicity to corals: A review. Marine Pollution Bulletin. 119(2):1-16.

Rogers, C. 1990. Responses of coral reefs and reef organisms to sedimentation. Marine Ecology Progress Series. 62: 185-202. 14

Turner, N., and D. Renegar. 2017. Petroleum hydrocarbon toxicity to corals: A review. Marine Pollution Bulletin. 119(2):1-16.

Categorical Exclusion (CE) Evaluation Worksheet

Project Identifier: EX2402

Date Review Completed: 3/29/2024

OAR NEPA Project Lead: Amanda Maxon, Environmental Compliance Specialist, Contractor, NOAA Office of Ocean Exploration and Research

OAR Functional Area: OER

Worksheet File Name: 2024-03-OER-E3-EX2402

Step 1. CE applicability

1. **Is this federal financial assistance, including via grants, cooperative agreements, loans, loan guarantees, interest subsidies, insurance, food commodities, direct appropriations, and transfers of property in place of money?**

   no

2. **What is the proposed federal action?**

   The proposed action is for NOAA's Office of Exploration and Research (OER) to complete the EX2402 Hawaii mapping expedition using the NOAA Ship Okeanos Explorer (EX) focused on exploring deep waters (greater than 200 m) in U.S. waters off the main Hawaiian islands and in the high seas. Operations will be conducted 24 hours per day and consist of mapping operations and full shore-based participation via telepresence. Expedition operations will include using Okeanos Explorer's scientific deep water sonar systems (Kongsberg EM 304 multibeam sonar, EK60/EK80 split-beam sonars, Knudsen 3260 Chirp sub-bottom profiler, and Teledyne acoustic Doppler current profilers), expendable bathythermograph (XBTs) in support of multibeam sonar mapping operations, conductivity, temperature, depth profiler (CTD) casts, and high-bandwidth satellite connection for continuous ship-to-shore communications.

   EX2402 Hawaii mapping expedition will commence May 14, 2024 from Honolulu, Hawaii and will conclude in Honolulu, Hawaii on June 9, 2024 for around 27 days at sea. Mapping operations will primarily be conducted in waters deeper than 200 m. The exact start and end dates may vary by a few days to weeks depending on weather and other

logistical considerations. Operations will be conducted 24 hours a day, and may consist of mapping operations, conductivity, temperature, and depth (CTD) operations, and full shore-based participation via telepresence. The action has independent utility and has not been inappropriately segmented from a larger federal action for review.

3. **Which class of CE in Appendix E of the NAO 216-6A Companion Manual is applicable to this action and why?**
   a. E3: Activities to collect aquatic, terrestrial, and atmospheric data in a non-destructive manner.
   b. The topical scope for this action is consistent with the CE number E3 in Appendix E of the Companion Manual to NOAA Administrative Order (NAO) 216-6A: to collect aquatic, terrestrial, and atmospheric data in a non-destructive manner. The expedition will potentially conduct calibrations of mapping sonars which will involve no permanent physical, chemical, or biological changes to the environment in areas deeper than 200 meters in depth. EX2402 will focus on performing mapping survey operations in the high seas and in areas of interest offshore of Hawaii which would not involve surface or land disturbance causing permanent changes to the environment. This expedition will perform mapping survey operations to collect critical baseline information to support priority NOAA science and management needs in Hawaii and its nearby waters. The use of conductivity, temperature and depth instruments, and XBTs will also occur during this expedition. Operations, deployment, and retrieval of these technologies will follow industry standards and applicable provisions under ESA, MMPA, MBTA, MSA, NMSA, and other local/specific regional regulations.

Step 2. Extraordinary Circumstances Consideration

4. **Would the action result in adverse effects on human health or safety that are not negligible?**

   The actions of the NOAA Ship Okeanos Explorer will primarily take place in remote deep-sea (>200m) areas located offshore of Hawaii with a focus on U.S. waters and the high seas. All operations are underwater and will have no human presence in the area besides those on onboard the EX2402. The vessel will transit through different depths as it moves from the ports of call to the areas of operations in deeper waters. These actions do not involve any procedures or outcomes known to result in impacts on human health and safety.

5. **Would the action result in adverse effects on an area with unique environmental characteristics that are not negligible?**

While the Okeanos Explorer is operating within the U.S. EEZ and high seas where majority of operations would take place, the effects will be negligible as acoustic mapping operations and XBTs are considered transient and would not cause any permanent impact on the seabed or within the water column. The procedures that are employed when operating acoustic systems impacts are well-documented and would follow the accepted best management practices for all operations onboard the vessel to ensure that the level of impact is below minor to the point of being barely detectable. Expedition operations are planned and reviewed before any actions are taken in order to determine whether there would be the potential for adverse effects on the area.

6. **Would the action result in adverse effects on species or habitats protected by the ESA, MMPA, MSA, NMSA, or MBTA that are not negligible?**

The activities are not likely to have a negative effect on species or habitats protected by the ESA, MMPA, MSA, NMSA, or MBTA. According to NOAA Fisheries, there are 22 ESA endangered and threatened species found within the Pacific Islands region. Okeanos Explorer operations will abide by the Best Management Practices and Mitigation Measures developed in collaboration with the various regulatory and federal agencies to ensure that operations in these sectors would not result in any activities having adverse effects on the species or habitats protected under ESA, MMPA, MSA, NMSA, or MBTA. Mitigation measures and Best Management Practices are provided to the expedition coordinators and the ship before operations are taken to ensure that they are following the actions developed to minimize or limit adverse effects on species or habitats in the proposed action area.

7. **Would the action result in the potential to generate, use, store, transport, or dispose of hazardous or toxic substances, in a manner that may have a significant effect on the environment?**

The expedition operations will be in compliance with FEC 07 Hazardous Materials and Hazardous Waste Management Requirements for Visiting Scientific Parties (or the OMAO procedure that supersedes it) to ensure generation, use, storage, transport, an disposal of such substances will not result in significant impacts.

8. **Would the action result in adverse effects on properties listed or eligible for listing on the National Register of Historic Places authorized by the National Historic Preservation Act of 1966, National Historic Landmarks designated by the Secretary of the Interior, or National Monuments designated through the Antiquities Act of 1906; Federally recognized Tribal and Native Alaskan lands, cultural or natural**

resources, or religious or cultural sites that cannot be resolved through applicable regulatory processes?

The proposed action will not result in adverse or indirect effects that cannot be resolved through applicable regulatory processes since we will not be operating within listed or eligible properties, lands, resources or sites coming under the umbrella of protection referenced above.

9. **Would the action result in a disproportionately high and adverse effect on the health or the environment of minority or low-income communities, compared to the impacts on other communities (EO 12898)?**

NOAA Ship Okeanos Explorer will be operating in the remote and offshore areas of the U.S. EEZ and high seas during EX2402. Operations will occur in the U.S. EEZ and in adjacent waters where there are no communities within or near the geographic scope of the expedition due to activities primarily operating in areas greater than 200 meters in depth. The expedition does not involve actions known or likely to result in adverse impacts on health or the environment of minority or low income communities.

10. **Would the action contribute to the introduction, continued existence, or spread of noxious weeds or nonnative invasive species known to occur in the area or actions that may promote the introduction, growth, or expansion of the range of the species?**

During EX2402, NOAA Ship Okeanos Explorer will make landfall in Kona, Hawaii for a small boat transfer and no additional areas other than commercial ports Honolulu, Hawaii. The ship and OER mission team will comply with all applicable local and federal regulations regarding the prevention or spread of invasive species. At the completion of every CTD cast, the equipment will be thoroughly rinsed with fresh water and completely dried to prevent spreading organisms from one site to another. Also the Engineering Department aboard NOAA Ship Okeanos Explorer attends yearly Ballast Management Training in accordance with NOAA Form 57-07-13 NPDES VGP Annual Inspection and Report to prevent the introduction of invasive species.

11. **Would the action result in a potential violation of Federal, State, or local law or requirements imposed for protection of the environment?**

OER has taken measures to ensure that any effects on species or habitats protected by the ESA, MMPA, MSA or NMSA meet the definition of negligible. The proposed actions will not result in any Federal, State, or local law violations or requirements imposed for protection of the environment. OER received a ESA Programmatic Letter of Concurrence and Project Design

Criteria letter dated March 14, 2022 from the NMFS ESA Interagency Cooperation Division for ESA Section 7 that concurs with OER's determination that the proposed action may affect, but is not likely to adversely affect ESA-listed species and their designated or proposed critical habitat in the action areas. The ESA Programmatic Letter of Concurrence and its Project Design Criteria will be provided in the EX2402 expedition report.

Given the offshore focus of most of our proposed work, it was determined that it is not likely that we will encounter marine mammals protected under the MMPA, or sea birds protected under the MBTA as they are often found in territorial and state waters. If we did encounter any such protected animals, our impacts would be negligible because of the best management practices that were developed with relevant agencies that we adhere to avoid or minimize environmental impacts. These best management practices and project designed criteria are outlined in the EX2402 project instructions and expedition report.

OER requested an Essential Fish Habitat (EFH) consultation under section 304 of the Magnuson-Stevens Fishery Conservation and Management Act for expeditions conducted by NOAA Ship Okeanos Explorer during its 2023 thru 2024 field season in the North Pacific Ocean, Eastern Pacific Ocean, Central Pacific Ocean, and Alaska. The EFH Letter of Acknowledgement was received on August 3, 2022 from the Assistant Regional Administrator for the NOAA Office of Habitat Conservation stating that the FY22 through FY24 expeditions will not adversely impact EFH. A reinitiation of the EFH consultation is being processed for the 2024 field season. This letter will additionally be included in the EX2402 expedition report.

12. Would the action result in highly controversial environmental effects?

No, the exploration activities are considered small and minimal following the best available information about the effects of the equipment to support the determination that activities would be localized and be short in duration in any particular area at any given time with no notable or lasting changes to the environment. Given the project's scope and breadth, no notable or lasting changes or highly controversial effects to the environment by mapping operations conducted onboard Okeanos Explorer. Any effects would be small and considered minimal as the vessel transits through the area of interest continuously using acoustic sound sources, which have been analyzed to determine the effects that may occur during operations.

13. Does the action have the potential to establish a precedent for future action or an action that represents a decision in principle about future actions with potentially significant environmental effects?

The decision to take this action will not result in growth-inducing changes, compel future actions with potential impacts, or foreclose options for future actions. Each expedition is independently useful and is not connected to subsequent federal actions.

14. Would the action result in environmental effects that are uncertain, unique, or unknown?

The techniques and equipment used are standard for this type of field study, and the effects are well known and assessed to determine whether the actions may result in environmental effects that are uncertain, unique, or unknown.

15. Does the action have the potential for significant cumulative impacts when the proposed action is combined with other past, present and reasonably foreseeable future actions, even though the impacts of the proposed action may not be significant by themselves?

The techniques and equipment used are standard for this type of field study, and the effects are well known and assessed to determine whether the actions may result in environmental effects that are uncertain, unique, or unknown.

CE Determination

☒I have determined that a Categorical Exclusion is the appropriate level of NEPA analysis for this action and that no extraordinary circumstances exist that would require preparation of an environmental assessment or environmental impact statement.

☐I have determined that an environmental assessment or environmental impact statement is required for this action.

OAR Decision Maker's Name: Jennifer Lukens

OAR Decision Maker's Position/Title: Deputy Director of NOAA Ocean Exploration

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Appendix C: EX2406 Daily Situation Reports

September 14, 2024: Departed Hilo, Hawai‘i at 1700 and started transit to the operation area. Sonars powered on and pinging, but not logging while we traveled through areas of excellent bathymetric coverage.

September 15, 2024: Transit continued. Drills ensured crew preparedness for emergency situations. Transit mapping covered a small gap south of Maui as line plan continues to larger and more consistent coverage gaps. CET/CST resolved issue with meteorological sensors not reporting data.

September 16, 2024: Transit mapping continued.

September 17, 2024: Transit mapping continued.

September 18, 2024: Arrived at priority area and began surveying. Interference across all sonars appeared after turning into conditions, but not immediately (~30 minutes after heading into conditions). Some troubleshooting steps, including securing single beam systems and confirming no interfering equipment was active were unable to confirm the source of interference. Additional troubleshooting planned for the following day.

September 19, 2024: Interference troubleshooting has not revealed a cause, but steps were taken to minimize the impact to multibeam data. Adjusted transmit along angle to -1 and found this improved interference issues. Disabling other sonar systems had no impact on the multibeam interference patterns. Adjusting the EK synchronization delay appeared to have no impact on the multibeam interference patterns.

September 20, 2024: Interference issues have been resolved without identifying a probable cause. The survey continued over the mid Pacific mountains.

September 21, 2024: Mapping continued in the priority region with data quality dependent on sea state. An issue was noted where EX2406 data were not appearing on the Live Operations map and an email message was queued up for Monday morning troubleshooting.

September 22, 2024: POS MV accuracy issues appeared towards the end of the line. Troubleshooting efforts continued into late hours and though currently stable, additional troubleshooting steps scheduled for following day.

September 23, 2024: Interference is still apparent in eastbound lines. Conditions reduced quality in the same direction such that only westbound data are useful. Mapping lines are currently being remapped west after mapping east until conditions improve. POS issues

remain and CST connected with Applanix for troubleshooting steps. Live Operations map issue reported on September 21 was resolved.

September 24, 2024: Live interaction scheduled for October 2nd. Mapping operations continue to repeat eastbound lines on the reciprocal course due to poor data quality in the eastbound direction. XBTs only collected on the westbound lines.

September 25, 2024: Mapping continued in overlapping lines as conditions began to improve enough that eastbound lines generate quality data. Applanix responded to request for troubleshooting assistance and advised that the region we are in is on the edge of satellite coverage for both OCSAT and ARSAT (previously had been using OCSAT). Applanix recommended not using the auto configuration that was selected when issues first appeared, switched to ARSAT, confirmed settings and restarted the POS. This significantly improved stability, but occasional accuracy dropouts were still experienced with the POSMV system.

September 26, 2024: Resumed standard survey pattern, data quality improved in the eastbound direction. Interference still apparent and source unknown. Live interaction scheduled for October 4th.

September 27, 2024: Survey continued in the priority area, moving from the shallower plateau regions of the mid-pacific mountains to adjacent deeper areas. Covered some data holidays and localized blowouts during the transit, as well as a crossing line.

September 28, 2024: Planned CTD cast was canceled due to non-functioning anti-two-block for the J-frame which could not be repaired onboard. Spares are being ordered and a possible interim solution may be borrowed from the Sette. Mapping continued in priority areas.

September 29, 2024: XBT auto launcher struggled with several launched and regular maintenance is planned to resolve sticky pins. Mapping continued in priority areas.

September 30, 2024: Troubleshooting and maintenance returned some AXBT launch tubes to working condition. Mapping continued in the priority survey area with good conditions and coverage.

October 1, 2024: Mapping continued with minor disruptions including SIS restart. Ship looped back to cover holiday.

October 2, 2024: Mapping continued in the priority survey area. POS MV issues continue to interrupt data collection but are resolved quickly. Live interaction with McKinzey Middle School was successful despite communications challenges.

October 3, 2024: Mapping continued in the priority area. Interference appeared in all sonars during eastbound mapping lines, but data quality appeared acceptable.

October 4, 2024: Gap filling mapping executed as transit towards Honolulu began. Live interaction held with North County High School. POSMV issues reported across the fleet and are not isolated to EX. CST emailed Applanix for further information. Interference reported in EK soundings associated with weather conditions.

October 5, 2024: Final live interaction held today. Mapping continued to fill small gaps while working back towards Honolulu.

October 6, 2024: Transit mapping initiated towards Honolulu, with routing around PMNM. Conditions expected to worsen during transit and mapping operations will be secured if deteriorating conditions prohibit quality data collection.

October 7, 2024: Transit mapping continued through worsening conditions.

October 8, 2024: Transit mapping partially secured during periods of poor conditions and low data quality. Resumed mapping as conditions improved and when crossing data gaps.

October 9, 2024: QA/QC initiated after securing from mapping operations for final transit approach to Honolulu.

October 10, 2024: Arrived in Honolulu and began demobilization.